

UNIVERSITY OF IDAHO

EXTENSION DIVISION

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FIGHTING ALFALFA WEEVIL

COOPERATIVE EXTENSION SERVICE IN AGRICULTURE
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SPRAYING WITH ARSENIC is the most practical, effective means yet devised for fighting the alfalfa weevil. The process is described in this bulletin. It is not expensive, where communities cooperate in purchase and use of the spraying apparatus. The control is effective, as the bulletin also indicates. Alfalfa growers, in general, have needed only to see the spraying method demonstrated, to be convinced of its value. Such demonstrations are available to all sections of the state, on application to the county farm bureaus for the assistance of specialists of the university extension division. The only limit on the time that can be devoted to any county will be the extent of aid that must be given to the other counties of the state.

TO THE DIRECTOR, ARSENIC IN
THE CONTROL OF THE ALFALFA WEEVIL
BY JAMES H. HARRIS, JR.
UNIVERSITY OF CALIFORNIA, BERKELEY

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FIGHTING ALFALFA WEEVIL

By CLAUDE WAKELAND

Extension Entomologist

IDAHO HAS NO CHOICE but to fight the alfalfa weevil. The weevil already is sufficiently abundant in some sections of Idaho, as in several other western states, to have caused serious losses. If uncontrolled, the weevil will destroy half the annual crop. Yet alfalfa is a crop for which there is no adequate substitute in the west, either as forage or in rotations. Fortunately, effective weevil control methods have been devised.

To fight the weevil, one first must know what it is. The most interesting facts about the weevil and the way to get rid of it are here summarized, and the page numbers of more extended discussions indicated.

WEEVIL BREVITIES

Native of Europe—The alfalfa weevil is a native of Europe, where it occurs generally, but is not especially destructive. (Page 5.)

Where Found in America—It was accidentally introduced into the United States and now occurs in Colorado, Idaho, Nevada, Oregon, Wyoming and Utah. (Page 5.)

The Way It Spreads—It spreads naturally by flying and crawling and may be carried artificially in numerous ways. (Page 6.)

What It Eats—It feeds on alfalfa, sweet clover, and many other legumes but does not feed on grasses, grains, timothy or wild hay. (Page 6.)

It Has Four Stages of Growth—There are four stages in the life cycle of the alfalfa weevil—egg, larva, pupa and adult. Eggs are yellow and are laid inside the stems in spring and summer. Larvae are green “worms” with light stripes on the backs and with black heads. Pupae are formed inside a frail, lace-like cocoon on the ground. Adults are brown snout-beetles about three-sixteenths of an inch long. They live over winter in protected places. There is but one generation each year. (Page 8.)

Damage It Does—Adults feed on plants but cause little injury. Serious damage is done by the larvae, which eat the foliage of the first crop and delay all later crops. (Page 12.)

Annual Loss—Annual loss from weevil without control measures may equal or exceed 50 per cent of crop. (Page 13.)

Prevents Seed Production—Alfalfa weevil will prevent production of seed where but one crop of alfalfa is raised. (Page 14.)

No Substitute for Alfalfa—No crop can be raised in the west that will take the place of alfalfa for forage and in rotations. (Page 14.)

Blamed for Poor Farming—Poor farming is often the cause of light hay yields which are attributed to alfalfa weevil. (Page 14.)

Good Farming—Loss from weevil is lessened by good farming (Page 14.)

Controlled by Spraying—The weevil is effectively controlled by spraying. (Page 15.)

One Spray Sufficient—One spray application at the right time on the first crop will protect all crops for a single year. (Page 16.)

Poison Used—Arsenic is used in spraying and applied so lightly that there is no danger to livestock from eating sprayed hay. (Page 18.)

When to Spray—The most effective time to spray is when larvae begin to do serious injury on the first crop. (Page 16.)

Precautions Which Will Save Much Trouble. (Page 18.)

Cost of Spraying—Cost of spraying is from 95c to \$1.25 per acre for the season. (Page 19.)

Where to Get Help—In response to requests made thru farm bureau organizations, the extension division conducts control demonstrations in infested communities. (Page 20.)

How to Reduce Spray Cost—It is practical for a community to organize and cooperate in the purchase and use of spray machinery. (Page 22.)

A Weevil Enemy—A weevil parasite is numerous in Idaho and is killing millions of weevil larvae annually. It is incapable alone of controlling alfalfa weevil, but with the help of other enemies which are known to occur in Europe it may control the weevil in time. (Page 25.)

Kind of Spray Apparatus—A spray machine which will develop enough pressure to deliver fine mist is necessary. (Page 17.)

Unsuccessful Control Practice—Brush-dragging, pasturing, and burning have been used with uncertain or poor results. (Page 22.)

THINGS THE WEEVIL DOES NOT DO

Eight things that the weevil does not do are listed below in response to numerous inquiries or in refutation of popularly accepted, erroneous ideas:

The weevil will not die out in time.

It does not kill out a stand of alfalfa.

There is no insect or natural enemy that is "exterminating" it.

It does not injure the roots or crowns of the alfalfa.

It does not bore into the roots or work inside of the stems.

It does not cause land values to depreciate; the assertion that it does is without foundation.

It does not cause good farmers to abandon alfalfa production. There are no cases on record where it has.

It is not a "small clover weevil," any more than a house fly is a small horse fly; they are separate and distinct insects.

NEW TO AMERICA; FOUND IN THE WEST

The alfalfa weevil (*) is comparatively new in America, being a native of Europe, where it has been known for more than a hundred years. It is now reported as being common in eastern Asia, northern Africa and over all of Europe where alfalfa is raised. It is also reported as not being particularly destructive to crops in its native home, this comparative harmlessness being due, as investigators inform us, to climatic conditions and to numerous enemies which hold it in check.

When the weevil was first discovered in the United States in 1904 it was confined to a few alfalfa fields in the vicinity of Salt Lake City, Utah. Its natural spread was slow for a few years and extended in all directions from the original source of infestation. In 1913 the pest had spread northward until it was present in the extreme southern part of Oneida, Franklin and Bear Lake counties in Idaho but was doing no appreciable damage. **At this time it had also made its way into southwestern Wyoming. During the years that followed, its progress continued steadily until in 1916 it occurred in most of central and northern Utah and had extended its hold in Idaho to several of the southeastern counties and a new infestation was discovered in western Colorado. Subsequently new colonies were reported from Madison and Payette counties in Idaho. It is probable that the three last-mentioned

**Phytonomus posticus*. Gyll.

**"The Alfalfa Weevil," by T. H. Parks; U. of I. Extension Bulletin No. 7.

infestations were caused by the weevil being hauled into these localities in hay or other products. At the close of the year 1920 the alfalfa weevil was known to occur over the central, western and northern part of Utah, in Gunnison, Delta and Montrose counties, Colorado, the southwestern corner of Wyoming, Malheur county, Oregon, 21 counties in Idaho as shown on the map on page 7, and during the year it was reported from Osceola, Tippetts and Reno, Nevada.

It is probably that at least four of the localities named became infested by the weevil being introduced artificially in produce shipped from weevil-infested localities. The natural spread is so rapid and sure and chances of the weevil being carried artificially to new localities so great that reports of infestations in new counties or states will occasion little surprise.

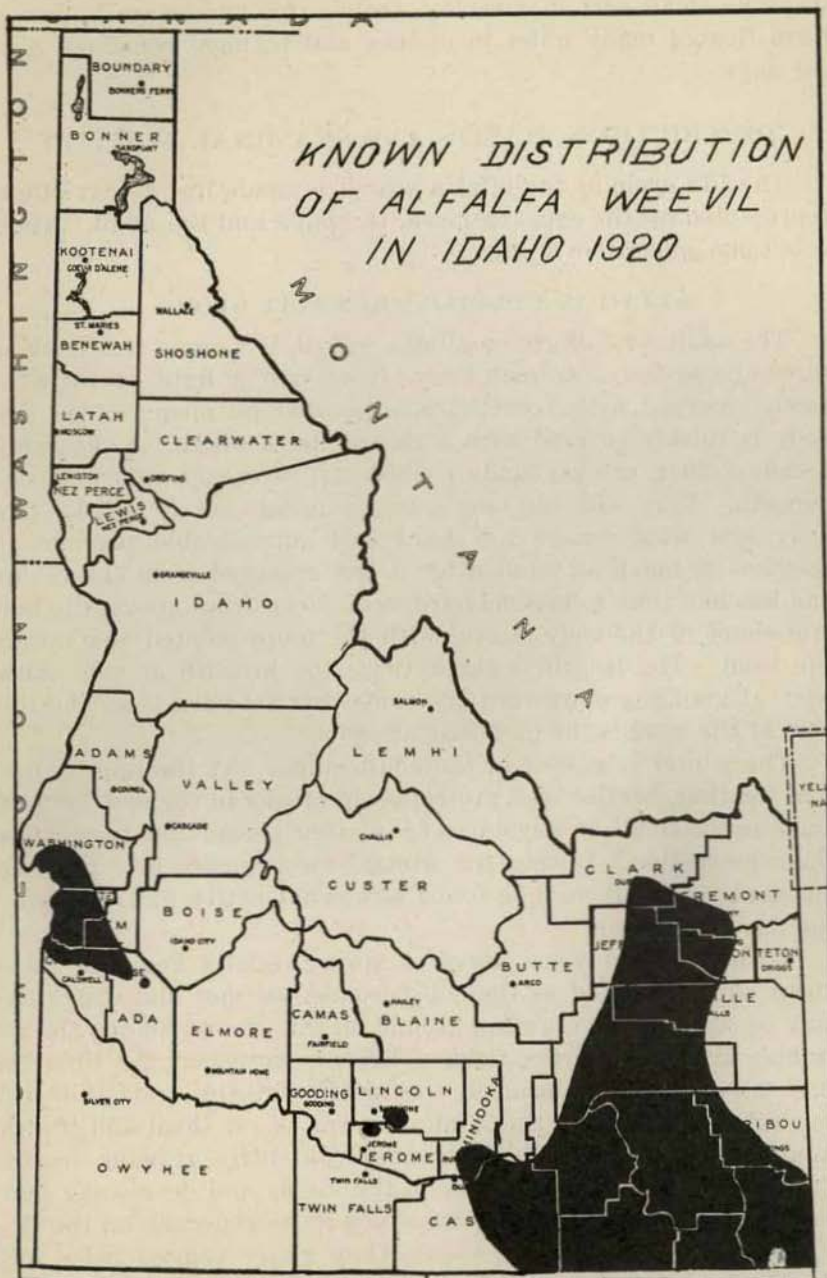
PLANTS THAT THE WEEVIL EATS

The alfalfa weevil feeds primarily on alfalfa but is known to live on many other legumes, among which are a few wild species, sweet clover, red clover and even peas and beans. The only plants on which the weevil has been observed to do injury in Idaho are alfalfa and sweet clover. It feeds quite generally on sweet clover; excessive injury to the plant, however, has been noted in but few instances. **The alfalfa weevil does not feed on wild hay, timothy, grasses or grain of any description.**

HOW IT REACHES NEW FIELDS

Natural Spread—The adult weevil has wings and it is possible that by flying it may spread many miles in a single season. Flight occurs during the warm spring and summer months. Adults are also active in crawling about on the ground during the warmer months and make their way from one field to another in this manner. So far as is known, there is no general migratory spread in any certain direction either by crawling or by flight.

Artificial Spread—It is problematical as to how the weevil was first brought to America or how it has since become established in new localities protected from older infestations by high ranges or wide stretches of barren land intervening. It could readily be carried in hay or straw, in shipments of fruit or household goods, in wagons, in bed-rolls or in a number of other ways. That it has been carried great distances by man's unwitting aid is a fact proven by the numerous isolated infestations. Irrigation water



plays no small part in carrying weevils, for adults are known to have floated many miles in ditches and to have remained alive for days.

DESCRIPTIONS, HABITS AND SEASONAL ACTIVITY

The life cycle of the alfalfa weevil is made up of four stages represented by the egg, the larva, the pupa and the adult. There is but one generation a year.

WEEVIL IS A BEETLE WHEN FULL GROWN

The adult, or full grown alfalfa weevil, is a snout beetle about three-sixteenths of an inch long. In color it is light brown when newly emerged with, sometimes, a peculiar purplish lustre. The body is thickly covered with scales or hairs which, as the beetle becomes older, are gradually rubbed off, revealing a darker color beneath. Very old specimens may appear nearly black. The body and wing covers are hard and considerable pressure is required to mash an adult after it has emerged from the cocoon and has had time to become hardened. Seen from above, the general shape of the body is oval with the more pointed end toward the head. The length is about twice the breadth at the widest part. Extending downward and somewhat forward from the fore part of the head is the proboscis or snout.

The winter is passed in the adult stage. At the approach of cold weather, beetles seek protection in cracks in the soil, beneath trash in the fields, in haystacks or in other places that may afford them protection. During the winter, they remain in a partially dormant state but may be found somewhat active at times when the days are warm.

With the first warm days of spring, adults begin to move about sluggishly and as the soil becomes warmer and drier they may be readily seen crawling around on the ground among the old stubble and trash in the field. They are active at the time the first green shoots appear in the alfalfa crowns and while the general appearance of the alfalfa crowns is yet dead and brown. Adults feed on green alfalfa thruout the entire growing season. Early in the spring, feeding is on the stems and developing leaf-buds, but as foliage develops, they feed more generally on the tips of the plants. With their snouts they gouge ragged holes into the stems or eat clean-cut holes thru the leaves and folded buds. Their feeding causes no appreciable injury.

It is difficult to observe adults even in heavily infested fields

unless one is careful in his movements. It is the habit of the beetles to "play possum" when disturbed. A person walking thru an alfalfa field creates a motion of the plants which disturbs the adults and they drop to the ground where they remain motionless for a time. To see them most readily, it is best for one to sit quietly in a field and watch. Soon the beetles will resume activity and may be observed in motion on the ground or in the tips of the alfalfa plants.

With its snout the beetle, when preparing to lay eggs, makes a small, round hole in a stem and gouges out a cavity within. By means of the special egg-laying organ (ovipositor) of the female, eggs are inserted thru the stem puncture and deposited in the cavity mentioned. Many egg punctures are left uncovered but some are filled with bits of chewed vegetation or with excrement.

Egg punctures in stems usually are easily distinguished from feeding punctures. The latter generally are larger, more irregular and usually do not extend deeply into the stem.

Adult beetles produced from the eggs of spring and summer, feed on alfalfa during the late summer and fall and females surviving the winter lay eggs the following spring and summer. The length of life of the adult is ten or eleven months and in some cases longer.

Adults begin to lay eggs in the spring as soon as the days become warm. The first eggs of the season are deposited within dead grass stems (not alfalfa stems) lying on the ground. As soon as the new growth attains a height of two or three inches, beetles begin to lay eggs in the thickened portions of the stem which are formed where a stem and the base of a leaf are enveloped by the stipule. The percentage of eggs laid in dead stems or while alfalfa plants are short, is comparatively small, but such eggs hatch into larvae that produce the earliest injury to growing plants. During the season of 1920 the bulk of the eggs were laid in early May in the Payette section of Idaho but in parts of the state farther east they were not deposited until late May and early June and in some of the higher elevations not until late in June.

WHAT THE EGGS ARE LIKE

The egg is about one-thirty-second of an inch in length, oval and, to the unaided eye, appears shiny. When first laid it is lemon-yellow or orange in color but as it becomes older and incubation progresses, it turns to light and later to dark olive. Just before hatching, a black spot, the head of the developing larva, may be seen thru the shell.

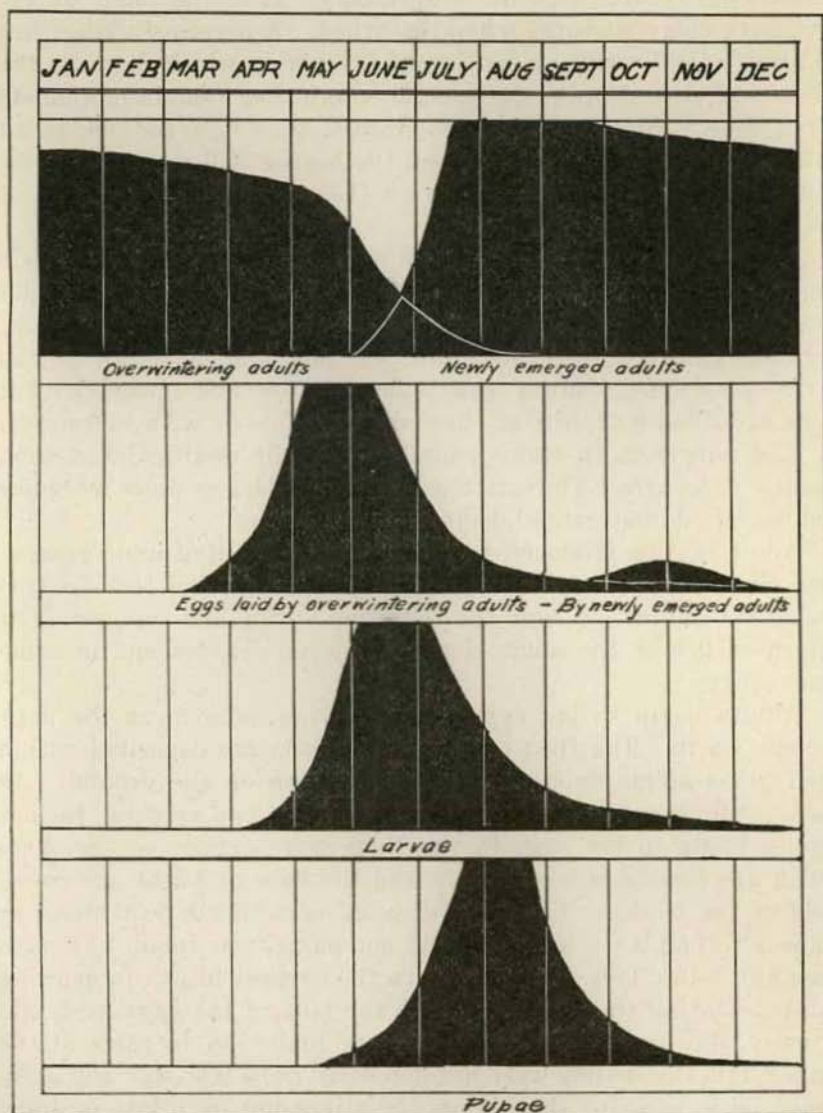


Chart showing time of year each stage of the weevil is present in the field and when the greatest numbers of each stage occur. Relative abundance of each stage cannot be judged by this chart.

Eggs may be laid singly within the stem punctures or in clusters of varying numbers. The number laid by each female varies, the average being between two hundred and three hundred. Eggs are present in the field in varying numbers at nearly all times during the growing season but are usually most abundant about two weeks before time of cutting the first crop of alfalfa.

Incubation progresses slowly during the cooler weather of spring and fall and is relatively much more rapid during late spring and early summer. The average length of the egg stage for the entire season is approximately fifteen days.

THE LARVA IS WORM-LIKE

The egg hatches into a tiny larva quite commonly called the "worm." When first hatched it is only about one-thirty-second of an inch in length and of yellowish-green color except the head, which is black. After the first molt (shedding of skin) it changes to a darker shade, an older larva assuming a general green color somewhat lighter than that of growing alfalfa. It is characterized by having a black head and a light stripe running lengthwise along the back. The larva molts three times and when fully grown is about one-fourth of an inch long.

Thru stem punctures, made by adults when the eggs were laid, newly emerged larvae make their way to the outside of the stems, thence to the tender buds in the tips of the plants, where they are protected, and there begin to feed. Early feeding is confined nearly altogether to folded buds, but as these unfold and new growth becomes scarce, the larvae make their way outward and attack the leaves. They are footless and their manner of clinging to a leaf is peculiar in that they nearly always curl themselves over the edge of it while feeding.

In the larval stage the weevil is helpless and is quite incapable of making its way to new fields unaided. It is, however, an aggressive feeder and it is while in this stage that injury to alfalfa is done. The average length of the larval stage is about twenty-two days.

PUPA IS ENCLOSED IN A LACE-LIKE COCOON

After the larva has completed its growth, it crawls or drops to the ground, where it spins a light, loosely-woven cocoon about itself. The cocoon usually is partly enclosed within a dry, curled alfalfa leaf or attached to stubble or trash. Within this cocoon the form of the weevil is changed entirely and soon the fully-formed adult beetle may be seen within, instead of the green

"worm" that originally spun the lace-like web. New adults formed within the cocoon are at first soft and greenish-brown. They later assume a light brown color and, after making their way out of the enclosing web, soon become hardened.

The time spent between the end of the larval period and the emerging of the adult is known as the pupal stage and averages thruout the season about sixteen days.

HOW THE WEEVIL CAUSES INJURY

Effect on First Crop—As previously mentioned, the first injury to growing plants in the spring is caused by adults which have survived the winter. Only small holes are made by adults and these may be found at any time during the growing season. After the first larvae attack the crop, the work of the adult is so slight in comparison as to be almost unnoticeable.

Larvae work within the unfolded buds as long as they are young and food is plentiful. As the buds are killed or eaten, the larvae make their way to the leaves, where they at first attack the epidermis (green skin) and quite often do not eat the tougher veins and mid-ribs. In the badly infested fields, however, entire leaves are eaten and the epidermis is stripped from the stem.

During the growth of the first crop, when the young larvae become quite numerous, the tips of the alfalfa plants assume a peculiar ash-gray color, due to dead tissue and small bits of excrement. As injury becomes more severe, the tips die and assume a yellowish brown color so that a badly infested field may have the appearance of having been frosted or of dying from lack of water. Even casual examination, however, will disclose the fact that the foliage is badly eaten.

The activity of the alfalfa weevil in Idaho is such that the injury is heaviest on the first crop of alfalfa. Generally speaking, the larvae are most numerous at or shortly before the time when blossom buds are easily noticed in the tips of the plants. In heavily infested fields the growth is checked when the larvae become numerous and, if nothing is done to combat their destructive work, the loss sustained on the first crop may be equal to or exceed fifty percent of the actual amount of the crop. Aside from the lessened quantity of hay obtained, its poor quality is an additional source of loss to the grower. Alfalfa that has been severely injured by weevil larvae makes a hay that is light in weight and of low nutritive value and is, as an Idaho farmer expresses it, "like feeding chaff."

The injury resulting from larvae in lightly infested fields is not easily noticed and a field may be infested for several years before the numbers have increased sufficiently to cause real injury. When larvae become numerous it is not uncommon to observe from six to ten or more of them feeding in the tips of each stem of an alfalfa plant.

Effect on Second and Later Crops—In fields where weevils are numerous, injury to the second crop is more easily noticed than is injury to the first, but it is finally outgrown. The first crop has made a heavy growth before the large number of larvae attack it and, if the alfalfa is growing rapidly and thriftily, the numbers of larvae have to be great before they can check its growth. Large numbers of larvae and pupae ordinarily are killed by the heat and sun after the first crop is cut, but while the hay is lying in the field a large percentage of them survive and make their way to the stubble. At such a time the larvae which had had an abundance of green food to live on are forced to survive on the small amount of remaining stubble and the short, tender shoots of the second crop. The result is that they strip the epidermis from the stubble and cut the new shoots back faster than they can develop. Within a few days they will have been so destructive that an infested field may be brown and dead in appearance and no growth will be made until after most of the larvae have entered the pupal stage and ceased feeding. It is not uncommon to see a second crop held back three or four weeks after the removal of the first crop of hay from the field. After the larvae cease their destruction the second crop matures and produces nearly a full amount of hay, where late season water is available, but it is cut so late that only a light third crop can mature.

Occasionally, when the first crop is cut, large numbers of larvae enter the pupal stage in the hay while it is lying in the field. These later emerge in the stack, make their way to an alfalfa field, if there is one close, and have been known to be numerous enough over a small area near a stack to cause injury quite similar to that of the larvae.

ANNUAL LOSS

Actual loss of hay is most severe on the first crop and almost complete loss of this crop is not uncommon. The annual loss in a badly infested field may equal or exceed fifty per cent of the entire crop.

ALFALFA SEED BUSINESS ENDANGERED

In the portions of Idaho where but a single crop is grown annually, the presence of the alfalfa weevil is a limiting factor which will in time make the production of alfalfa seed unprofitable and even impossible without the practice of control measures. A heavily infested field is so severely injured that but very few or no blossoms are developed; hence the raising of seed is out of the question.

ALFALFA THE CHIEF CROP IN IDAHO

Alfalfa is the most important crop of our state when considered in relation to all phases of agriculture. Aside from the actual production of hay, this legume occupies an important place in any practical rotation scheme, and its value as a soil building crop is too well known to warrant discussion here. There is no other crop that is so well adapted to our semi-arid climate, that will grow under such varied and often adverse conditions and that forms so nearly a complete feed ration.

WEEVIL OFTEN BLAMED FOR POOR FARMING

It is a fact, admitted by farmers generally, that there is no crop on the farm that is worse neglected than alfalfa. A field is seeded and produces abundantly for three or four years and is forgotten except for an irrigation occasionally or when the hay is cut. Frequently one finds alfalfa fields in this state that have been seeded from twenty to thirty years and which have been producing less and less each year until their annual yield is but a fraction of what it could be. When such fields become infested with alfalfa weevil many farmers awaken suddenly to the low yields they have been obtaining and they often blame it all on the weevil, little realizing or perhaps not admitting that poor farming is largely responsible for their reduced crops. Alfalfa land that is treated fairly will respond in proportion whether it is weevil infested or not, but if it is not treated fairly, the crop has little chance when it is attacked by the pest. It costs just as much to fight alfalfa weevil on a light stand or in a field that is poorly cared for as it does where good farm practices are followed and the returns are proportionately less.

LOSS CAN BE LESSENERED BY GOOD CULTURAL METHODS

Good farm practice includes a number of points in relation to alfalfa raising. While important in alfalfa hay or seed production

in any community these points demand added emphasis when considered in relation to weevil-infested fields.

Good Stand Is Essential—The first requisite to a maximum production of hay is a good stand of alfalfa. A fortunate factor regarding the raising of alfalfa in a weevil-infested community is that a good stand may be obtained in spite of the pest and with only ordinary care. Seedlings of alfalfa are attacked but lightly the first year and the plants have an opportunity to become well established before the weevil becomes destructive on them.

Spring Cultivation Stimulates Growth—Assuming that the stand of alfalfa is good, any treatment that induces an early start in the spring and constant, rapid growth during the development of the first crop is highly desirable. Opinions of practical farmers generally and observations by various experiment stations point to the fact that early spring cultivation tends to warm up the soil, promotes better drainage and air circulation and establishes a protective mulch, all of which aid in producing an early and vigorous growth of alfalfa. Another important feature of cultivation is that it reduces greatly the numbers of weeds and undesirable grasses in the field. A good implement to use for this spring cultivation is the springtooth harrow. It should be set and weighted so as to penetrate the soil to a depth of three inches. The field should be harrowed once in one direction and again in another direction at right angles to the first. **Spring cultivation is not to be confused with brush-dragging, which will be spoken of later.**

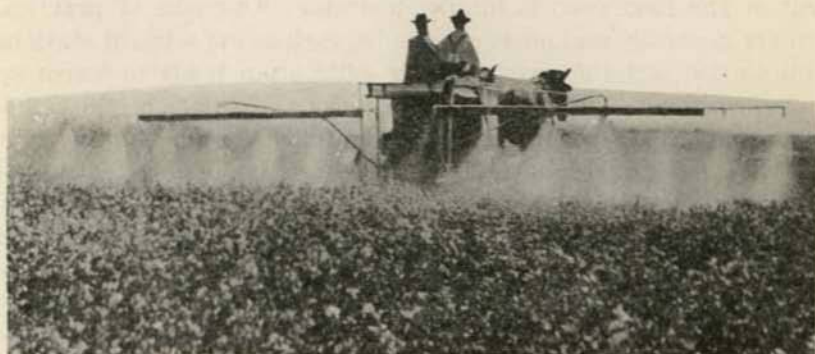
Irrigation is an Important Factor—Each farmer will do well to consider carefully his type of soil and adopt the method of irrigation, which will promote steady, rapid growth of his alfalfa. In general frequent irrigations, using water in moderation will promote more uniform and rapid growth than heavier applications at longer intervals. Bearing out this statement is the experience of many Idaho farmers who have at times lacked their usual allotment of water. By judicious use of a small head of water they have obtained extra good yields of both hay and seed. Care in laying out laterals and marking out fields in the spring is essential to even distribution of irrigation water thruout the season.

ALFALFA WEEVIL CAN BE CONTROLLED

For years we have heard much about the alfalfa weevil and the terrible menace it is to the alfalfa industry of the west, but it is

stripped of its terror when we consider that it can be controlled effectively and economically by spraying and that it is possible for the alfalfa grower to protect himself if he is prepared. The United States Bureau of Entomology has conducted extensive experiments in controlling the weevil by spraying, and other experiments along the same line have been carried on in Colorado. The results of experiments have proven that spraying can be relied upon as a practical method of control.

As the result of work done by the United States Bureau of Entomology more than 4000 acres of alfalfa were sprayed in Utah by farmers in 1919. During 1920, in one county alone in the same state, 3500 acres were sprayed and farmers are enthusiastic in



SPRAYING FOR THE CONTROL OF ALFALFA WEEVIL

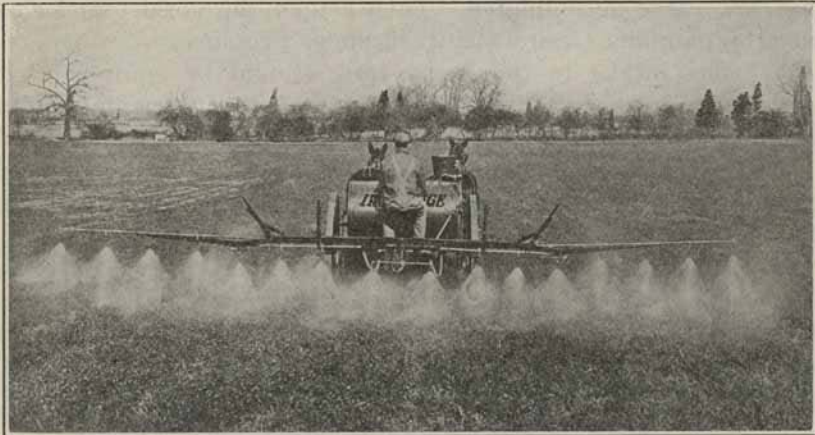
support of this method of control. This shows that spraying has passed out of the experimental stage and has been adopted generally as a farm practice in some localities.

WHEN SHOULD SPRAYING BE DONE?

A spray applied at the time eggs are hatching in greatest numbers and correspondingly large numbers of larvae are attacking the foliage will greatly reduce the damage to the first crop and it may grow until the normal time of cutting. Each man will have to watch his own crop to determine when spray should be applied. In general the best results are obtained when spraying is done at the time injury to the foliage becomes easily noticeable and is increasing rapidly. This usually is about two weeks before the date of cutting the first crop, but varies, and there is sufficient leeway that any farmer, by watching closely the appearance of his crop, can secure good results.

WHAT KIND OF SPRAYING APPARATUS IS BEST?

To date, kinds of apparatus used for spraying alfalfa have been adaptations of orchard engine power sprayers, which have been satisfactory in their work, but their use is open to the objection of high first cost and the care necessary for operation and maintenance. Where a farmer already owns a power outfit it is possible for him to equip it for alfalfa spraying at small cost. Those wishing so to equip for weevil control are referred to the United States Department of Agriculture Farmer's Bulletin No. 1185, "Spraying for the Alfalfa Weevil," which goes into the matter in detail. It may be secured by addressing the Division of Publications, United States Department of Agriculture, or the University of Idaho, Extension Division, Boise, Idaho.



Simple Type of Spray Machine Which is Well Adapted to Alfalfa Spraying

There is on the market at present a traction power sprayer which in a recent field test worked very satisfactorily. It sprays a width of 26 feet and has the advantage of being light in weight, of light draft and costing only a third as much as the engine power-machines. Manufacturers are working to perfect machines more suitable for weevil control and types of apparatus are changing rapidly. Those contemplating the purchase of a spray machine for alfalfa spraying alone are advised to communicate first with the University Extension Division, Boise, Idaho, which is constantly in touch with new developments.

Generally speaking, any spray machine which will develop pressure enough to force the liquid out of the spray nozzles in a fine mist will give satisfactory results. The number of nozzles

which can be supplied and the width of ground covered will be governed by the capacity of the pump used and the pressure which it is able to develop and maintain. The machine used by the University Extension Division for demonstrations in 1920 was equipped with 14 nozzles which delivered the spray mist over a thirty-foot width of alfalfa and as fast as a team could walk. The nozzle which has been most generally used and which gives satisfaction is of the eddy-chamber type with renewable discs, the holes in the discs being three-sixty-fourths of an inch in diameter.

THESE PRECAUTIONS WILL SAVE TROUBLE

1. Before starting to spray, clean out the tank thoroly and, before screwing on the nozzles, force clean water thru the pump and all connections to remove any iron scales, trash or sediment that may have accumulated. Then attach the nozzles and clean them by pumping clean water thru under pressure.

2. The intake to the spray tank should be equipped with forty-mesh brass screen which fits snugly into the opening and all water and spray materials should be strained thru it into the tank.

3. Sediment accumulates in the bottom of the tank and forms small lumps. To avoid trouble from this source, clean out the tank thoroly from time to time during the season.

4. When thru with the spray machine for the season or for any length of time, force clear water thru all pipes and connections to wash out any solid matter that might later collect and dry to form lumps.

Minutes spent in observing the above precautions will save hours of valuable time in the field when every minute counts.

POISONS THAT ARE EFFECTIVE AND SAFE

The poisons used have been various arsenicals, all of which have given good results in actual field work. Calcium arsenate is being more generally used than arsenate of lead or arsenite of zinc because of its higher arsenic content and lesser cost. It is used at the rate of two pounds of calcium arsenate to 100 gallons of water, which amount is sufficient to spray about one acre of alfalfa. There is no danger of poisoning livestock by feeding sprayed hay, provided proper directions are followed in spraying.

WHEN IS SPRAYING JUSTIFIABLE?

When a field first becomes infested with alfalfa weevil, spraying has no possibilities as a means of preventing the weevil from increasing to a point where it does damage. It is not profitable for

an alfalfa grower to spray until the weevil is causing loss enough to warrant the expenditure. It is important, however, that he be prepared and know how to protect his crop when the time comes for action.

CAPACITY OF SPRAYING MACHINE

A power spray machine equipped for alfalfa spraying should have a working capacity under field conditions of about 30 acres per day. In any community there is usually enough variance in field conditions and weevil development that spraying may be done effectively over a period of ten days. It is thus possible by the use of one machine to control the weevil on about 300 acres of alfalfa in a single year.

SPRAYING IS NOT EXPENSIVE

With reasonable care a well-made spray machine should be in good working condition for at least ten years. Assuming that repairs during these ten years amount to as much as the original cost of the machine (unless machine is abused, repairs will cost much less) we have the following figures:

Cost of Spraying with Power Spray Machine

Cost of machine with alfalfa spraying equipment.....	\$ 750.00
Cost of repairs on machine for ten years.....	750.00
Cost of calcium arsenate for 3000 acres—6000 pounds @ 25c.....	1,500.00
Cost of man and team labor, 100 days @ \$8.00.....	800.00
Gas and oil for engine, ten years.....	150.00
Total.....	\$3,750.00
Cost per acre.....	\$ 1.25

Cost of Spraying with Traction Sprayer

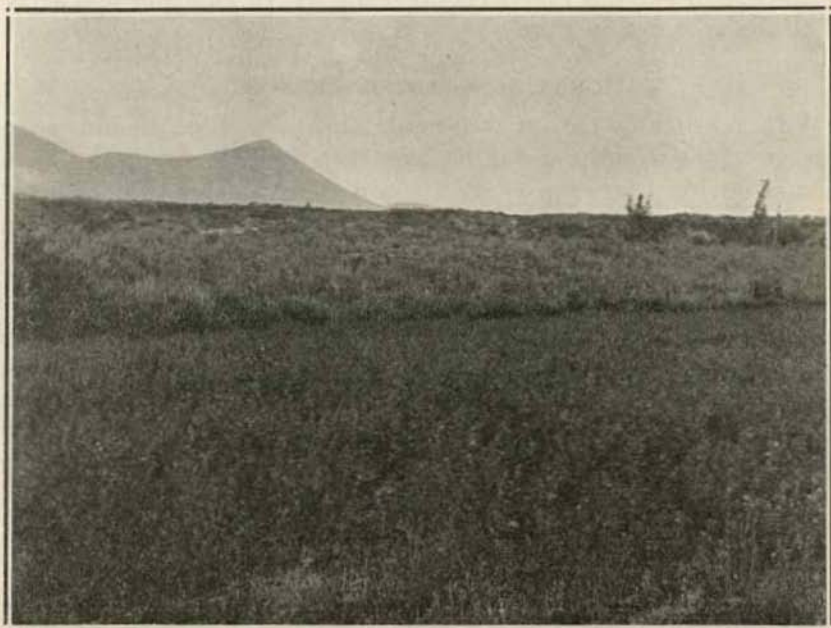
Cost of machine, complete with pump for filling.....	\$ 300.00
Cost of repairs for ten years.....	300.00
Cost of calcium arsenate for 3000 acres—6000 pounds @ 25c.....	1,500.00
Cost of man and team, 100 days @ \$8.00.....	800.00
Total.....	\$2,900.00
Cost per acre.....	97c

HOW SPRAYING AFFECTS THE CROPS

First Crop—When poison spray is applied to an infested field at the proper time the effects are soon noticeable. Weevil larvae are killed or made to cease feeding after they have eaten poisoned foliage and within a few days a sprayed field will begin to throw out new growth, take on a brighter green color and will blossom freely. It may be left until normal time for cutting and little injury is discernible. Under the same condition a field unsprayed

will set no blossom and must be cut early to save the crop from almost complete destruction.

Second Crop—After the first crop has been removed from a heavily infested field, which was sprayed, the second crop begins growth immediately and within a few days the field has assumed a general green appearance. An unsprayed field, under the same conditions, will make no growth and will remain brown and dead in appearance for a period of three weeks or more. Thus the crop on an unsprayed field may be held back for a period nearly equal to the normal time of growth of the crop.



Second Growth of Alfalfa on Sprayed Portion of Field. Photo Taken Three Weeks After Cutting of First Crop.

Later Crops—In parts of the state where third or fourth crops are obtained there is no weevil injury to the stubble and the crops begin to grow as soon as the second crop is removed. They are so late in maturing, however, that unless spray has been applied at the right time on the first crop, little or no hay can mature.

FARM BUREAU SPRAY DEMONSTRATIONS

With weevil control as with many other things, "seeing is believing." Spraying alfalfa may sound vague and fanciful to a

farmer when he reads or hears about it, but when he sees how practical it is and how definite are the results, he is quick to apply the practice to his own weevil-infested fields. The extension division of the university is organized and maintained in response to the demand for help from farmers. It would be possible for but few farmers to make a long trip to see spray operations and other trips later to see results, so it is the plan of the extension division to go into each community where the demand exists, and conduct a spray demonstration. Thus it is within the power of every



Second Growth of Alfalfa on Unsprayed Portion of Same Field Shown in Opposite Picture. Photo Taken on Same Day as That of Opposite Picture

weevil-infested community of Idaho to see control operation and results if it will take advantage of its opportunity. The plan is simple and consists of making a request for a demonstration to your county agent. He, in turn, will arrange for a demonstration with the extension division, and will select a field well located where it may be seen by the largest numbers of people passing by, and will give publicity to the proposed demonstration. When it is time for effective spraying the extension division will send a representative and apparatus to your community who, with your help

and that of the county agent, will conduct a practical field demonstration. The number of demonstrations is limited only by the needs of the communities and the time of the demonstrators.

A PRACTICAL COMMUNITY PLAN

As previously stated, the capacity of a spray machine during a single season is about 300 acres. Very few farmers in Idaho have enough land seeded to alfalfa to warrant the purchase alone of a large machine. The average of alfalfa per farmer probably does not exceed thirty acres. It is thus possible that eight or ten men, whose combined alfalfa acreage does not exceed 300, may work cooperatively in their purchase and use of spray machinery. Under most conditions, it is advisable that small communities



Group of Farmers in Attendance at a Spray Demonstration

follow this plan, for apparatus is so expensive and so utterly unfitted for other farming operations as to be prohibitive in cost unless it is made to serve the largest possible use. While purchase and use is cooperative, it will, in general, be best to place one man in charge of the spray machine who will take care of it and with whom suitable arrangements can be made for doing the spraying for the entire community.

LIMITED CONTROL METHODS

Brush dragging, pasturing with sheep and burning are control methods which are practical only under special or limited conditions.

BRUSH DRAGGING

Brush dragging has been relied upon to some extent in controlling alfalfa weevil. As an emergency means of control, under certain conditions, it possesses merit but is not to be recommended as a practical, dependable method. It is based on the facts that

larvae, pupae and adults are quite easily killed by dust and dry heat. The usual practice is to cut the first crop early and to then work up a loose dust mulch by use of a brush drag or a common harrow under which is fastened brush or layers of woven wire. Success in creating a dust mulch necessitates a dry field at cutting time. A farmer cannot regulate this factor and a rain may interfere any year with his control plans. Presuming that a dry field is possible, it is not advisable as a good farm practice, for irrigation shortly before cutting the first crop is advantageous in stimulating a rapid growth of second crop shoots and in reducing dust in the hay. Dust mulch also often necessitates re-marking the field before it can be irrigated. Points for and against dust mulch are:

1. It will control weevil on second and third crops under limited conditions.



DEMONSTRATION SPRAY MACHINE IN TRANSPORT

2. It will not prevent loss on first crop.
3. It cannot be relied upon every year.
4. It has been discarded by farmers who have given it a thoro test.
5. It is expensive and slow and must be done while other work is pressing.
6. It is not good farm practice.

PASTURING WITH SHEEP

Pasturing alfalfa with sheep may, under certain conditions, be considered as offering relief in controlling the weevil and presents a source of early feed to the sheep man before forest reserves

and ranges are accessible. It cannot be considered very generally, however, because of the fact that average farm practice will not permit the farmer to have sheep enough to keep his alfalfa closely pastured. Under limited conditions some farmers may pasture sheep on alfalfa early in the spring with but little harm to the crop and at a financial gain that may offset the reduction resulting from delayed growth. Facts concerning the pasturing of sheep to reduce loss from alfalfa weevil are:

1. There is little danger of sheep bloating when they are turned on alfalfa early in the spring and run continuously in numbers large enough to keep growth eaten back closely.

2. Sheep will pack the surface soil but will affect the lower soil little. Fields cultivated thoroly and irrigated immediately after the removal of the sheep have been known to yield almost as heavily and mature nearly as soon as fields not pastured.

3. Pasturing reduces loss from weevil by allowing no growth to be made until after the date when most of the weevil eggs are hatched. This means that sheep will have to be held in the field until the first of June or later.*

BURNING

Frequently inquiries are received asking if weevil cannot be controlled by burning the land over with gasoline torches or with straw. Both methods have been tried but results have been poor and cost of operation is prohibitive.

CULTIVATION FOR WEEVIL CONTROL

As mentioned elsewhere, cultivation early in the spring is of value in stimulating a rapid, healthy growth of alfalfa and thus aiding it better to withstand weevil attack, but cultivation cannot be said to have any direct effect in killing or controlling alfalfa weevil.

Frequently the assertion is made by a farmer that he will "eradicate the weevil" by plowing up all his alfalfa. If the stand is old and thin, this is the proper thing to do, but it will not eradicate weevil. When a new stand is obtained it will be infested in a short time as badly as was the old. If a farmer has a good stand of alfalfa, he should, by all means, care for it and control the weevil by spraying rather than by destroying a stand, the equal of which he may not easily obtain again.

*Nearly the first of July in some counties of Idaho in 1920.

NATURAL ENEMIES OF THE WEEVIL

Introduction of natural enemies of the alfalfa weevil into this country was undertaken by the United States Bureau of Entomology during the years 1912 and 1913. A number of species of insects were collected in Europe, brought to America and liberated in the vicinity of Salt Lake City. It has since developed that but one species, an ichneumon fly,* has become established. This fly has increased and spread rapidly and may be found in much of the territory occupied by the alfalfa weevil.

Work done during 1920 by the university extension division discloses the fact that the parasite is present in all of the eastern and southern counties of Idaho where alfalfa weevil occurs, but apparently it had not spread across the barren country west of these counties. To facilitate its spread, it was artificially introduced into Minidoka, Payette and Ada counties and further introductions will be made during succeeding years.

The female of this ichneumon fly searches out a weevil larva on the alfalfa plant and, piercing its body with her ovipositor (egg-laying organ) lays an egg inside. This egg in time hatches into a small larva which feeds and grows inside the body of the weevil larva but does not kill it until after the weevil larva spins a cocoon preparatory to pupating. Then, instead of the pupa being formed, the larva of the parasite makes its way out of the skin of the weevil larva, which it has killed, spins a light web and immediately goes into the pupal stage. There is at least a partial second generation of the parasite and it is probable that this second generation is nearly or quite as large as the first.

In rare instances 80 per cent and even 90 per cent of alfalfa weevil larvae in the field have been observed parasitized by this insect. It is very abundant in parts of Idaho but there is no evidence that it is playing any active part in weevil control, for fields where it is plentiful are apparently as severely injured as those where it does not occur.

It is a fact that alfalfa weevil in Europe has not been the pest that it has proven to be in America and it is quite probable that its natural enemies are holding it in check. Reports of reliable investigators show that there are various other enemies which attack other stages of the weevil as effectively as the ichneumon fly mentioned, does the larva. If successful introduction into America and colonization of these enemies can be accomplished, it is possible that in time they will become abundant enough to have the same beneficial effect they are credited with in Europe.**

**Bathyplectes curculionis*.

**Further work on alfalfa weevil parasites will be undertaken in this year (1921) by the U. S. Bureau of Entomology.

CONTROL OF WEEVIL BY DUSTING

The extension division and experiment station conducted a number of tests in 1920 on the control of alfalfa weevil by the use of the arsenical dusts applied in the dry form. Application was made by the use of a small traction duster and results obtained lead to the belief that dusting compares quite favorably with spraying. Until further work is done, however, dusting cannot be recommended for general use. Its many advantages are obvious and if, after further tests, it proves successful, it no doubt will come into use quite generally and in time may supplant spraying in certain parts of the state.



Traction Dusting Machine in Operation in an Alfalfa Field

ACKNOWLEDGMENT

Acknowledgment is made to the U. S. Bureau of Entomology and to the Colorado State Department of Entomology for certain information contained in this bulletin. Especial acknowledgment is made for the use of cuts of pictures of sprayed and unsprayed fields which were loaned by the Colorado Department of Entomology.

ANNOUNCEMENT

Insect Laboratory Conducted by Extension Division

In order to learn of the injurious insects of Idaho and know how to combat them, it is necessary to maintain a complete record of the localities where they occur, the plants they feed on, and the injury they do as well as the names and species of the insects themselves. A great deal of this information can be supplied by farmers and county workers, but the determination of species will necessarily be restricted to specialists.

To meet an apparent need, the extension division has established an insect laboratory in Boise. It is well equipped for mounting, rearing, and collecting work, and a specialist will be in attendance at all times to receive and care for any material sent by the farmers or county workers of the state. The complete cooperation of all concerned is desired, and to aid both the specialists and the public the following directions should be closely followed:

1. If larvae or "worms" are destroying vegetation or crops, enclose a few of them in a strong box with some of the green food on which they are feeding, and mail it to the Extension Entomologist, Boise, Idaho.

2. If adults (moths, beetles, etc.,) are sent, put them in a strong box, wrap securely and mail. Individuals will be less likely to become damaged if wrapped lightly in soft tissue paper or cotton, and a number of insects packed together without protection may destroy one another.

3. Insects should never be placed in bottles with tight stoppers as the moisture is likely soon to spoil them. If a bottle is used, use soft cotton for a stopper.

4. Never send insects in a letter or in a fragile package. It is not uncommon to receive the remains of a package or letter, but the insects have been completely lost or destroyed in transit.

5. Write a letter stating facts about food plants of injurious insects, nature and extent of damage. Address all letters and packages to Entomologist, University Extension Division, Boise, Idaho.

APPENDIX

Journal of the Proceedings of the General Assembly

The first part of the proceedings was devoted to the consideration of the report of the Finance Committee. The report was read and approved. The Committee had recommended that the sum of £10,000 should be granted to the Education Department for the purpose of providing for the purchase of new books and the repair of the library. The Assembly agreed to the recommendation.

The second part of the proceedings was devoted to the consideration of the report of the Education Committee. The report was read and approved. The Committee had recommended that the sum of £5,000 should be granted to the Education Department for the purpose of providing for the purchase of new books and the repair of the library. The Assembly agreed to the recommendation.

The third part of the proceedings was devoted to the consideration of the report of the Health Committee. The report was read and approved. The Committee had recommended that the sum of £2,000 should be granted to the Health Department for the purpose of providing for the purchase of new books and the repair of the library. The Assembly agreed to the recommendation.

The fourth part of the proceedings was devoted to the consideration of the report of the Public Works Committee. The report was read and approved. The Committee had recommended that the sum of £1,000 should be granted to the Public Works Department for the purpose of providing for the purchase of new books and the repair of the library. The Assembly agreed to the recommendation.

The fifth part of the proceedings was devoted to the consideration of the report of the General Committee. The report was read and approved. The Committee had recommended that the sum of £1,000 should be granted to the General Committee for the purpose of providing for the purchase of new books and the repair of the library. The Assembly agreed to the recommendation.